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EXAMINER

LEE, HSIEN MING

ART UNIT	PAPER NUMBER
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2823

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DATE MAILED: 10/23/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/675,023

Applicant(s)

BURTON ET AL.

Examiner

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 24 September 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-21 and 23-68 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-21 and 23-68 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

1. Applicants' CPA request filed 9/24/02 is acknowledged. Claims 65-68 are newly added.

Thus, claims 1-21, 23-68 are pending in the application.

Claim Objections

2. Claims 14, 15, 29, 30 and 65-68 are objected to because of the following informalities:

“a thickness in the range of about 10 to about 500 angstroms” (in claim 14). Changing into “a thickness in the range of **from** about 10 to about 500 angstroms” is suggested. The same true also holds in claims 15, 29 and 30.

Furthermore, in newly added claims 65-68, the phrase “ the semiconductor layer “ is not consistent with the term recited in the base claims. Changing into – the **compound** semiconductor layer -- is suggested. Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Amended claims 1, 21, 34 and 36 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The newly added limitation “ wherein additional overlayers of conductive metal are not necessary in the ohmic contact” is **new matter** and not described in the as-filed specification.

The only paragraph in the as-filed specification that the Examiner may relate to is “ a low sheet resistance layer 1301” as shown in Fig. 13 and related text described on page 9, second paragraph. The as-filed specification, however, does not indicate that the “low sheet resistance layer 1301” is the “ overlayers of conductive metal.”

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claims 1 and 36 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted step is forming “ additional overlayers of conductive metal.”

7. Claims 21, 34, 43 and 44 are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. R

Regarding claims 21 and 34, the omitted structural cooperative relationships are: the relevant location of the “additional overlayers of conductive metal” with respect to the region of the “ refractory layer” or the “ reactive layer.”

Regarding claims 43 and 44, the omitted structural cooperative relationships are the entire processing steps reciting in claims 1 and 36, respectively; wherein claims 43 and 44 are considered “ product-by-process” claim. By reciting “ made by the method of claim1” and “ made by the method of claim 36” is not acceptable.

8. Claims 1, 7, 12, 21, 27, 32, 34, 36 and 45-48 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

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The language “said refractory layer is substantially free of gold” as recited in the respective claims 1, 21, 34 and 36 renders indefinite because “**substantially free** of gold” does not give metes and bounds. (emphasis added)

21.
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Furthermore, the language “additional overlayers of conductive metal are not necessary in the ohmic contact” as recited in claims 1, 21, 34 and 36 is vague because the “**not necessary** in” would raise a doubt whether the “additional overlayers of conductive metal” is “**in** the ohmic contact” or “**not in** the ohmic contact.” (emphasis added) If the “additional overlayers of conductive metal” were “**not in** ohmic contact”, then why the “additional conductive metal” would be called “overlayers.” To the Examiner, “overlayers” means that the “additional **overlayers** of conductive metal” are formed **over** the “refractory layer.” Accordingly, the “additional **overlayers** of conductive metal” should be **in** the ohmic contact since the underlying “reactive layer” and the overlying “refractory layer” constitutes the “ohmic contact.”

Alternative limitation as recited in claims 1, 7 and 21 is unacceptable. One acceptable form of alternative expression, which is commonly referred to as a Markush group. The acceptable form for claims 1, 7 and 21 would be either “electrically conductive material is chosen from **the group consisting of** nickel, ruthenium, vanadium, gold, and cobalt” or “electrically conductive material **is** nickel, ruthenium, vanadium, gold **or** cobalt.” See M.P.E.P. 2173.05(h), I.

Furthermore, alternative limitation as recited in claims 12 and 27 is also unacceptable, i.e. “material selected from the group **comprising** titanium, molybdenum, tungsten, TiW, metal nitrides, metal silicide and metal borides.” (emphasis added) The acceptable form should be “material selected from the group **consisting of** titanium, molybdenum, tungsten, TiW, metal

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nitrides, metal silicide and metal borides.” (emphasis added) Particularly, M.P.E.P.

2173.05(h), I. states that ‘ It is improper to use the term “ comprising” instead of “ consisting of.”

Ex parte Dotter, 12 USPQ 382 (Bd. App. 1931).

The limitations “ the ohmic contact can be used in a laser diode, a light emitting diode, a Schottky, a field effect transistor, a metal-semiconductor field effect transistor, a metal-oxide-semiconductor field effect transistor, **and** a high electron mobility transistor”, as recited in claims 45-48, should be changed into -- the ohmic contact can be used in a laser diode, a light emitting diode, a Schottky, a field effect transistor, a metal-semiconductor field effect transistor, a metal-oxide-semiconductor field effect transistor, **or** a high electron mobility transistor --. (emphasis added) See M.P.E.P. 2173.05(h), II.

The limitation “ a thickness of at least about 100 angstroms” as recited in claim 32 renders indefinite because the phrase “ at least” had no upper limit. See M.P.E.P. 2163.05 , III and 2173.05 (b), A.

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

10. Claims 1, 2, 7-9, 12-13, 19-21, 23-25, 27-28, 34, 36, 43-48 and 61-64 are rejected under 35 U.S.C. 102(b) as being anticipated by Yanagihara et al. (US 5,523,623).

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Regarding claims 1, 7-9, 12-13 and 36, Yanagihara et al. in Fig 2B and related text identically teach the claimed method for forming an ohmic contact on a semiconductor layer comprising :

- depositing a reactive layer 21 comprising at least electrically conductive material on at least a portion of a compound semiconductor layer 2 (p-type GaAs); wherein the at least electrically conductive material is a multilayered film 21 comprising a Ni film (14), a Ti film (15) (as an adhesive element) and a Pt film (16) (col. 5, lines 36-41);
- depositing a refractory layer 17 comprising electrically conductive material Ti on the reactive layer 21, wherein said refractory layer 17 is free of gold; and
- depositing additional overlayers of conductive metal 14, 15, 16, 17, 18 over a resist pattern 13, wherein the additional overlayers of conductive metal 14, 15, 16, 17, 18 are not in the ohmic contact, wherein the ohmic contact is formed in the opening of the resist pattern 13.

(Remark) Since the phrase “ additional overlayers of conductive metal are not necessary in the ohmic contact” violates the 112-second paragraph requirement as mentioned above, the Examiner would interpret the phrase at his best comprehension and make the 102 (b) rejection as above.

Regarding claim 2, Yanagihara et al. also teach that the compound semiconductor layer comprises InGaAsP (col. 8, lines 3-6).

Regarding claims 19 and 20, Yanagihara et al. also teach that the reactive and refractory layers are formed by a well-known technique such as evaporation (col. 7, lines 65-66).

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Regarding claims 21, 23-25, 27-28, 34, 43 and 44, Yanagihara et al. in Fig 2B and related text also identically teach the claimed ohmic contact comprising :

- a reactive layer 21 comprising at least electrically conductive material on at least a portion of a compound semiconductor layer 2 (p-type GaAs); wherein the at least electrically conductive material is not an alloy but a multilayered film 21 comprising a Ni film (14), a Ti film (15) (as an adhesive element) and a Pt film (16) (col. 5, lines 36-41);
- a refractory layer 17 comprising electrically conductive material Ti on the reactive layer 21, wherein said refractory layer 17 is free of gold; and
- additional overlayers of conductive metal 14, 15, 16, 17, 18 over a resist pattern 13, wherein the additional overlayers of conductive metal 14, 15, 16, 17, 18 are not in the ohmic contact, wherein the ohmic contact is formed in the opening of the resist pattern 13.

Regarding claims 45-48, Yanagihara et al. also teach that the method would also apply to the application of a Schottky diode (i.e. Schottky junction) (col. 1, lines 19-29; col. 7, lines 32-35) and transistor (col. 2, lines 43-48).

Regarding claims 61-64, Yanagihara et al. also teach depositing a low sheet resistance layer such as Pt (18) onto the refractory layer (17) (Fig.2B).

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

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having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

12. Claims 3-5, 10, 37-40 and 65-68 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yanagihara et al. (US '623) in view of Yagura et al. (US 6,188,137).

Regarding claims 3-5, 37-40 and 65-68, Yanagihara et al. fail to expressly teach that the compound semiconductor layer comprises $\text{In}_x\text{Ga}_{1-x}\text{As}$, wherein $0.05 < x < 1.00$ or $0.3 < x < 0.8$ or approximately 0.6. However, $\text{In}_x\text{Ga}_{1-x}\text{As}$ is considered an art recognized equivalence of GaAs-based compound semiconductor, wherein the range of x can be from 0 to 1 or equals to 0.66, as evidenced by Yagura et al ; wherein the $\text{In}_x\text{Ga}_{1-x}\text{As}$ of Yagura et al. is a n-type semiconductor layer (col.3, lines 55-56 and col. 4, line 12).

Therefore, it would have been obvious to one of the ordinary skill in the art at the time of the invention was made to use $\text{In}_x\text{Ga}_{1-x}\text{As}$ as the compound semiconductor layer, wherein $0 < x < 1$; or $x=0.66$ as taught by Yagura et al. in Yanagihara's method for forming the ohmic contact since by doing so it would provide a satisfactory ohmic contact structure with low contact resistance (col. 3, lines 14-18, Yagura et al.).

Regarding claim 10, the above combined teachings of Yanagihara et al and Yagura et al. teaches that the satisfactory ohmic contact structure can be formed by depositing the reactive layer 21 of Yanagihara et al on the $\text{In}_x\text{Ga}_{1-x}\text{As}$ of Yagura et al.; depositing the refractory layer 17 of Yanagihara et al on the reactive layer 21; and depositing the additional overlayers of conductive metal 14-18 over the resist pattern 13. The motivation/suggestion for doing so would be to obtain the ohmic contact structure with a low contact resistance (col. 3, lines 14-18, Yagura et al.)

13. Claims 6, 14-18, 26, 29-33, 35, 41 and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yanagihara et al. (US '623) in view of Uchibori et al . (US 5,982,036).

Regarding claims 6 and 41, Yanagihara et al. teach the claimed method for forming the ohmic contact on the compound semiconductor layer comprising GaAs but fail to teach the compound semiconductor layer comprising InAs. Uchibori et al . in an analogous art teach forming multi-layered structure 306/305/304 as the ohmic contact on the InAs layer 303, wherein the multi-layered structure 306/305/304 comprising a Ni film (304), which is formed on the InAs layer 303 (Figs. 4A-4D).

Therefore, it would have been obvious to one of the ordinary skill in the art at the time of the invention was made to use the InAs as the compound semiconductor layer as taught by Uchibori et al in Yanagihara's method so that the reactive layer, Ni (14), can be formed on the InAs layer since InAs is an art-recognized equivalence to GaAs and by this manner it would benefit the subsequent annealing processing step (col. 8, lines 1-12, Uchibori et al) and obtain the ohmic contact with low contact resistance (Fig. 5, Uchibori et al).

Regarding claims 26, 35 and 42, the selection of atomic percent of an adhesive element (such as Ti) in the reactive layer is obvious because it is a matter of determining optimum process condition by routine experimentation. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). In such a situation, applicants must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results. See M.P.E.P. 2144.05

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III. In this regard, the as-filed specification does not demonstrate any criticality regarding the claimed range (refers to specification on page 6, lines 2-22).

Regarding claims 14-18 and 29-33, the selection of the thickness of the reactive layer as well as the refractory layer is obvious because it is a matter of determining optimum process condition by routine experimentation. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). In such a situation, applicants must show that the particular range is critical, generally by showing that the claimed thickness achieves unexpected results. See M.P.E.P. 2144.05 III. In this regard, the as-filed specification does not demonstrate any criticality regarding the claimed thickness range (refers to specification on page 6, lines 11-12).

14. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yanagihara et al. (US '623) in view of Yagura et al . (US '137) as applied to claims 1 and 4 above, and further in view of Uchibori et al . (US '036).

The combined teachings of Yanagihara et al. and Yagura et al . substantially teaches the claimed method comprising the adhesive element (Ti) as stated above but fails to expressly teach that the amount of the adhesive element in the reactive layer comprises from about 5 to about 45 atomic percent. However, the selection of atomic percent of an adhesive element (such as Ti) in the reactive layer is obvious because it is a matter of determining optimum process condition by routine experimentation. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). In

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such a situation, applicants must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results. See M.P.E.P. 2144.05 III. In this regard, the as-filed specification does not demonstrate any criticality regarding the claimed range (refers to specification on page 6, lines 2-22).

15. Claims 49-60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yanagihara et al. (US '623) in view of Yagura et al . (US '137) as applied to claims 1, 21, 36 above, and further in view of Bernhardt et al. (US 5,583,355).

The combination of Yanagihara et al. and Yagura et al. substantially teaches the method for forming the ohmic contact comprising depositing the reactive layer on the compound semiconductor layer and depositing the refractory layer on the reactive layer but fails to teach depositing a dielectric layer onto the refractory layer, depositing a nitride liner onto the dielectric layer and depositing a spacer onto the nitride liner.

Bernhardt et al. in an analogous art of forming an ohmic contact (Fig.5) teach depositing a dielectric layer 17 onto the electrode 16, which is equivalent to the portion of reactive and refractory layers of Yanagihara et al. and Yagura et al.; depositing a nitride liner 18 onto a portion of the dielectric layer 17; and depositing a spacer 23A and 23B onto a portion of the nitride liner 18.

Therefore, one of the ordinary skill in the art, at the time of the invention was made, would have been motivated to deposit a desired dielectric layer, as taught by Bernhardt et al, on the refractory layer of Yanagihara et al. and Yagura et al followed by depositing the nitride liner onto the dielectric layer and then a spacer onto the nitride liner since by doing so it would protect

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the reactive and refractory layers from the damages of subsequent etching process during the formation of the ohmic contact.

Response to Arguments

16. Applicant's arguments filed 9/24/02 have been fully considered but they are not persuasive.

Applicants argue that Yanagihara et al. do not teach or suggest the feature “additional overlayers of conductive metal are not necessary in the ohmic contact” as amended. The feature, however, is **new matter** and not described in the as-filed specification. Furthermore, the as-filed specification does not describe **how and where** to form the “additional overlayers of conductive metal” with respect to the region of the “ohmic contact” or the “reactive layer” or the “refractory layer.” Accordingly, the above feature has been treated based on the best comprehension of the Examiner as the rejections stated above.

Applicants also argue that Yanagihara et al has three metal layer (the Examiner assumes that it refers to the multi-layered film including Ni, Pt and Ti) that are heated to approximately 400 C to form an alloy, which is different from the present invention, wherein the reactive layer and the refractory layer are distinct layers, and not merely metals that are heated to comprise an alloy. (page 7, third paragraph).

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., the reactive layer and the refractory layer are distinct layers, and not heated to comprise an alloy) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification,

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limitations from the specification are **not read into the claims**. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). (emphasis added)

Furthermore, claims 1 and 21 merely recite “ depositing a reactive layer comprising at least electrically conductive material on at least a portion of a compound semiconductor layer, wherein the at least one electrically conductive material is chosen from nickel, ruthenium, vanadium, gold, and cobalt”, wherein the transitional phrase “ comprising at least” is **inclusive or open-ended** and does **not exclude** additional, unrecited elements or method steps. See M.P.E.P. 2111.03 Therefore, Yanagihara’s reference still reads on the claimed invention because the multi-layered film can be broadly interpreted as the “ reactive layer” and does “comprises at least one electrically conductive material “, i.e. “nickel.” In other words, it is **not** an issue whether the “ reactive layer is an “ alloy” or “distinct layers” but if the prior art teaches the claimed features “**depositing a reactive layer comprising at least electrically conductive material** on at least a portion of a compound semiconductor layer, **wherein the at least one electrically conductive material is chosen from nickel**, ruthenium, vanadium, gold, and cobalt .” (emphasis added)

For the reasons above, the rejections as set forth in this Office Action is deemed proper.

17. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Olik Chaudhuri, can be reached on 703-306-2794. The fax phone numbers for the


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organization where this application or proceeding is assigned are 703-305-0142 for regular communications and 703-305-0142 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Hsien Ming Lee
October 21, 2002